

**Notice of Allowability**

Application No.

10/632,474

Examiner

Cheryl Lewis

Applicant(s)

WU ET AL.

Art Unit

2167

**-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--**

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to the applicants' communication filed on August 1, 2003.
2. ☒ The allowed claim(s) is/are 1-32.
3. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some\* c) ☐ None of the:
- ☐ Certified copies of the priority documents have been received.
  - ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
  - ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

\* Certified copies not received: \_\_\_\_\_.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.

**THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.**

4. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.
5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
- (a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached
- 1) ☐ hereto or 2) ☐ to Paper No./Mail Date \_\_\_\_\_.
- (b) ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date \_\_\_\_\_.
- Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

**Attachment(s)**

- ☒ Notice of References Cited (PTO-892)
- ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- ☒ Information Disclosure Statements (PTO-1449 or PTO/SB/08), Paper No./Mail Date 12/7/05
- ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
- ☐ Notice of Informal Patent Application (PTO-152)
- ☐ Interview Summary (PTO-413), Paper No./Mail Date \_\_\_\_\_
- ☒ Examiner's Amendment/Comment
- ☐ Examiner's Statement of Reasons for Allowance
- ☐ Other \_\_\_\_\_

### **DETAILED ACTION**

1. Claims 1-32 are allowed.

### **INFORMATION DISCLOSURE STATEMENT**

2. The information disclosure statements filed on December 7, 2005, complies with the provisions of MPEP § 609. They have been placed in the application file, and the information referred to therein has been considered as to the merits.

### ***Drawings***

3. The drawings filed on August 1, 2003 are accepted by the Examiner.

### **EXAMINER'S AMENDMENT**

4. An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it **MUST** be submitted no later than the payment of the issue fee.

Authorization for this examiner's amendment was given in a telephone interview with Guojun Zhou on February 28, 2006.

5. Claims 1, 5, and 17 have been amended as follows:

Claim 1. (Currently Amended) A computer implemented method for automatically collecting garbage objects, comprising:

Art Unit: 2167

performing root set enumeration in a stack of a thread using a stack trace cache;  
obtaining a root set by combining references obtained from root set enumeration  
for all threads;

tracing live objects that are reachable from references in the root set; and  
reclaiming storage space occupied by objects other than the live objects.

Claim 5. (Currently Amended) A computer implemented method for  
performing root set enumeration in a stack of a thread for automatic garbage collection,  
comprising:

initializing a stack enumeration list;  
creating a stack trace cache for the thread; and  
performing root set enumeration in the stack using the stack trace cache to  
produce an updated stack enumeration list.

Claim 17. (Currently Amended) A computer implemented system for root set  
enumeration in a stack during garbage collection, comprising:

a stack frame classifier capable of classifying a stack frame based on a tag of the  
stack frame;

a stack information caching mechanism capable of caching information of the  
stack frame in a stack trace cache, if the value of the tag indicates that the stack frame  
is not cached;

an unchanged trace detecting mechanism capable of detecting a portion of stack  
trace information that has not changed since the last stack enumeration in the stack  
trace cache, if the value of the tag indicates that the stack frame is cached; and

an unchanged trace retrieving mechanism capable of retrieving the unchanged portion of stack trace information from the stack trace cache.

### **REASONS FOR ALLOWANCE**

6. The following is a statement of reasons for the indication of allowable subject matter:

The closest prior art, Li (Pat. No. 6,978,285 B2) teaches "Enumeration of each running thread 320, 322 provides a live object reference root set, or set of useful object references of the thread, from which a set of live memory locations can be identified. Stale or garbage memory locations can then be inferred from the set of live memory locations." (column 5, lines 41-46). Further, Li teaches "Upon receipt of the request, the root set identifiers 310, 320 of each running thread 320, 322 enumerates its associated thread (block 406) to identify the thread's root set of live object references. The root set identifiers 310, 312 report the enumeration results back to the garbage memory identifier 304. In the illustrated example, each of the running threads 320, 322, enumerate themselves in parallel while continuing execution in their associated processor(s) 104. In other words, there is no processor idle time during concurrent self-enumeration (column 5, lines 54-63).

The closest prior art Ebrahim et al. (Pat. No. 5,893,121) teaches "The CPU 102 includes an instruction cache 120 for providing instructions to an instruction decoder and execution logic 122. The CPU also includes a stack cache 124 for storing in high speed cache memory a portion of the program stack 114, and a set of registers 126 for

Art Unit: 2167

storing data values, object references 128 and the like. The program stack 114, including the portion in the stack cache 124, is used to temporarily store various data structures and parameters, including activation records (sometimes called "frames") 130 that are pushed on the program stack each time a method or other procedure is invoked. During garbage collection, the program stack 114, and the registers 126 in the CPU 102 are typically used to locate a "root set" of object references or pointers used by mutator task 112. A root set locator procedure in the garbage collector will typically generate and store a root set list 132 of the located root set object references (column 5, lines 37-54).

However, Li nor Ebrahim teach or fairly suggest the claim limitations of independent claims 1, 5, and 17 that are cited in the examiner's amendment above.

Also, Li nor Ebrahim teach or fairly suggest the following:

Claim 14 recites: 'a virtual machine; a just-in-time compiler; at least one stack trace cache capable of storing trace information of stack frames when the stack frames are enumerated during root set enumeration' and similarly recited in independent claims 20 and 24.

The remaining claims 2-4, 6-13, 15, 16, 18, 19, 21-23, and 25-32, comprise dependent claims, thus these claims are patently distinct over the art of record for at least the above reasons.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany

Art Unit: 2167

the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

### **NAME OF CONTACT**

7. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Cheryl Lewis whose telephone number is (571) 272-4113. The examiner can normally be reached on 6:30-3:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, John Breene can be reached on (571) 272-4107. The fax phone number for the organization where this application or proceeding is assigned is (571) 273-8300.

(571) 273-4113 (Use this FAX #, only after approval by Examiner, for "INFORMAL" or "DRAFT" communication. Examiners may request that a formal paper/amendment be faxed directly to them on occasions.).

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist/ Technology Center (571) 272-2100.

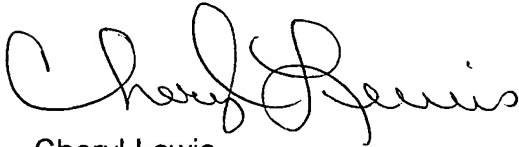
Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only.

Art Unit: 2167

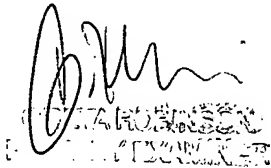
For more information about the PAIR system, see <http://pair-direct.uspto.gov>.

Should you have questions on access to the Private PAIR system, contact the

Electronic Business Center (EBC) at 866-217-9197 (toll-free).

A handwritten signature in cursive script, appearing to read "Cheryl Lewis".

Cheryl Lewis  
Patent Examiner  
March 1, 2006

A handwritten signature in cursive script, appearing to read "Cheryl Lewis", positioned above a rectangular official stamp. The stamp contains text that is partially obscured but appears to include "Patent Examiner" and "March 1, 2006".